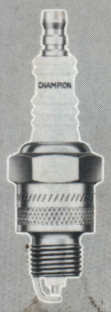

DEPENDABLE
CHAMPION
SPARK PLUGS

Giving Two-Way Radio Its Voice

With over two million mobile radios now in operation and the prospect of having this number doubled in the next decade, the problem of ignition noise suppression has become increasingly important.

The mobile commercial radio is an entirely different "breed of cat" compared to the ordinary passenger car receiver. More numerous and more efficient vehicle suppression components are required. In fact, there's a difference between ignition noise and ignition interference. While one is audible... the other may be inaudible, yet greatly lower receiver efficiency. FM and AM radio frequencies also call for different suppression techniques.

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By Champion Spark Plug Co.

GIVING TWO

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Please direct all inquiries on

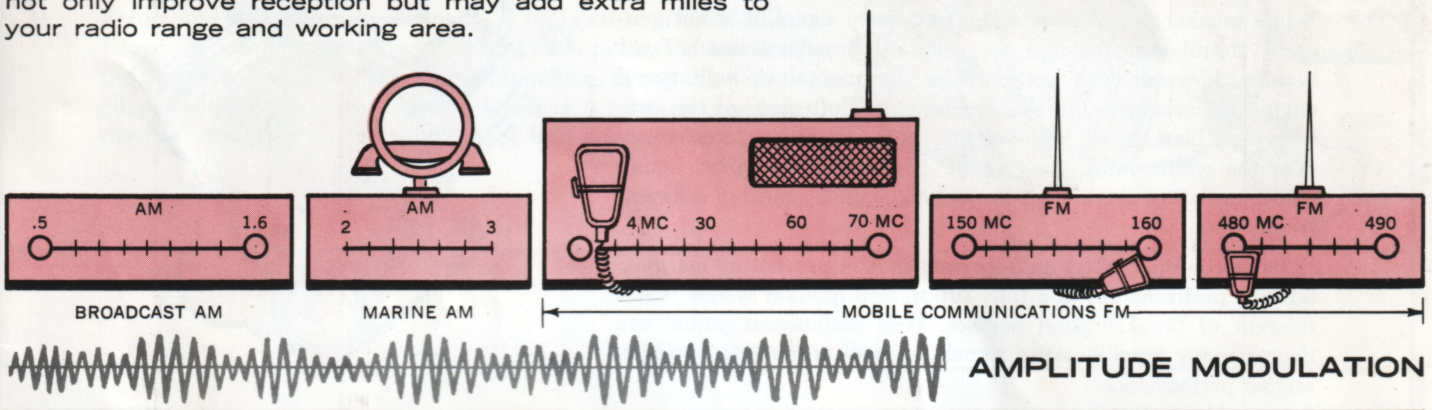
ignition, engine suppression, and resistor or non-resistor spark plug applications

TO: AUTOMOTIVE TECHNICAL SERVICES DEPT.
CHAMPION SPARK PLUG CO.
TOLEDO 1, OHIO

DEPENDABLE CHAMPION SPARK PLUGS

-WAY RADIO ITS VOICE

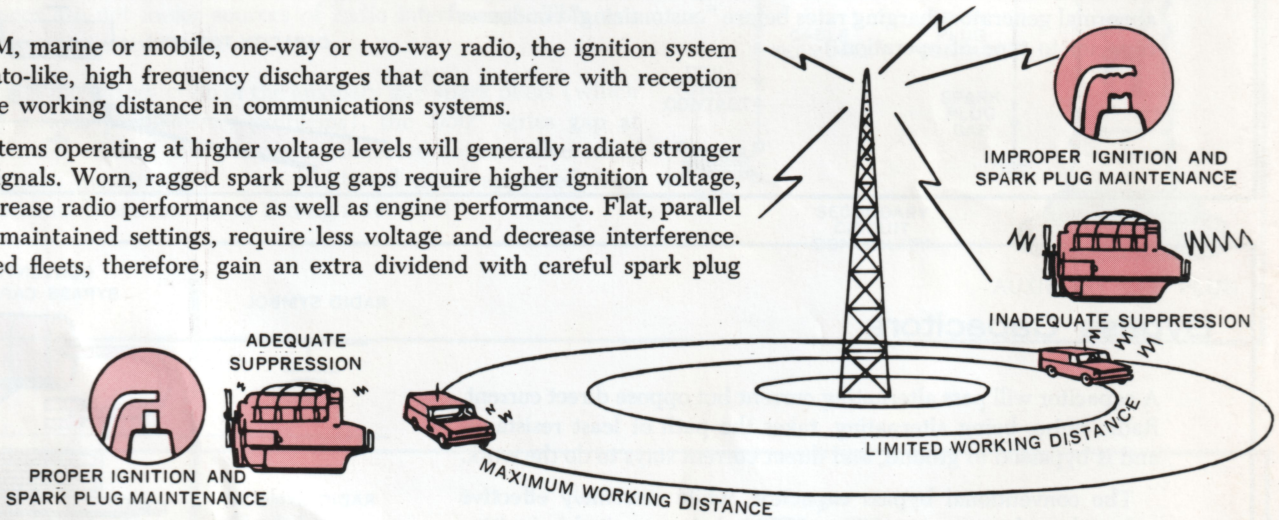
Higher voltage levels in present day engines . . . plus more sensitive receivers . . . make two-way radio interference a growing problem. Here are suppression techniques which not only improve reception but may add extra miles to your radio range and working area.



THE IMPORTANCE OF SPARK PLUG MAINTENANCE

In AM and FM, marine or mobile, one-way or two-way radio, the ignition system radiates staccato-like, high frequency discharges that can interfere with reception and reduce the working distance in communications systems.

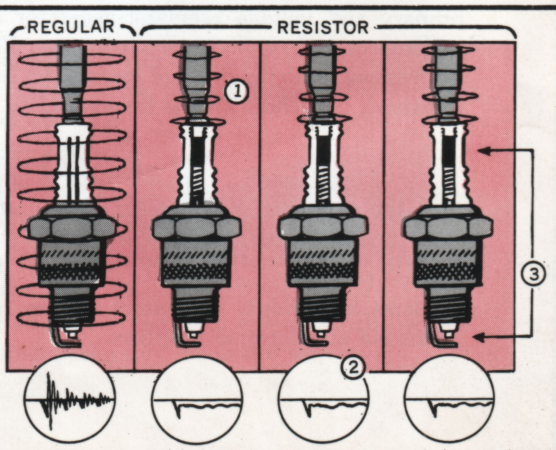
Ignition systems operating at higher voltage levels will generally radiate stronger interference signals. Worn, ragged spark plug gaps require higher ignition voltage, hence can decrease radio performance as well as engine performance. Flat, parallel gaps, factory maintained settings, require less voltage and decrease interference. Radio-equipped fleets, therefore, gain an extra dividend with careful spark plug maintenance.



How The Champion Resistor Plug Maintains "Silence"

In two-way radio, Champion resistor spark plugs are a very effective means of noise suppression for three important reasons:

1) Troublesome radio noise radiating from cables is greatly reduced in strength.
2) The high frequency part of the spark is "chopped off."
3) The resistor is built into the spark plug (the nearer a resistor is to a spark gap, the more effective it is).



OF "PRIMARY" IMPORTANCE

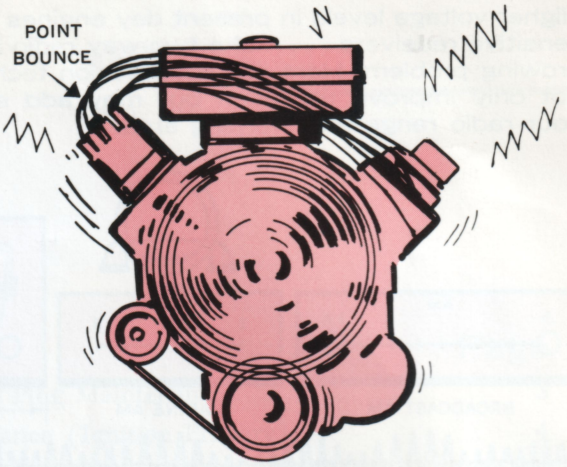
The Ignition Primary

While breaker points emit a low frequency signal, it is not generally troublesome beyond the standard broadcast band. Point bounce, however, can not only be detrimental to high speed engine performance, but the intermittent "fluttering" of the contacts can blast rapid high-voltage, high-frequency interference over the whole radio spectrum . . . the secondary wiring acting as the radiating agent with its various lengths emitting different frequencies.

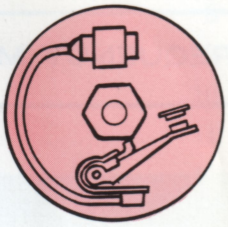
Point condition plays an important part in preventing marginal ignition performance, as a fully suppressed ignition system is less tolerant of breaker point neglect. Well maintained points will decrease any possible noise signals, as well as provide optimum engine performance.

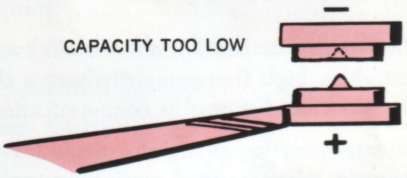
Two-way fleets can often improve point performance by mating condenser capacity to the type of fleet operation; this avoids premature point pitting. Taking allowable mfd. range for the vehicle, the operator can select condensers at the highest mfd. limit for start-stop, long idle—lowest mfd. for high speed operation.

Too low a capacity generally shows up as a crater in the negative contact . . . too high a capacity as a crater in the positive contact. (Make certain there are no loose primary connections or abnormal generator charging rates before "customizing" condenser capacity to type of operation.)



FOR EXAMPLE:
If condenser capacity is .18 to .25 mfd, select .18 for Hi-Speed . . . select .25 for start-stop

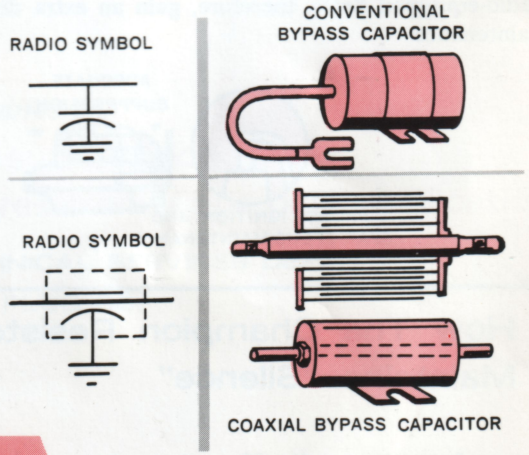




Bypass Capacitors

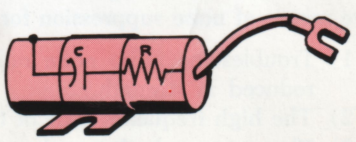
A capacitor will pass alternating current but oppose direct current. Radio noise, being alternating, takes the path of least resistance and is bypassed to ground, and direct current stays to do the work.

The conventional bypass capacitor, while extremely effective at broadcast frequencies (550 to 1550 kc), is not suited in ignition primary and voltage regulator-generator alternator circuits for suppression at frequencies above approx. 2000 kc (2 mc). Mobile frequencies up to hundreds of megacycles demand a more efficient bypassing capacitor. This is the coaxial or feed-through type.



Never install a bypass capacitor on the field terminal of a voltage regulator. An RC filter may be used. This is a special bypass capacitor with a resistor in series.

Some heavy duty generators require special filters—these are available at electronic suppliers.

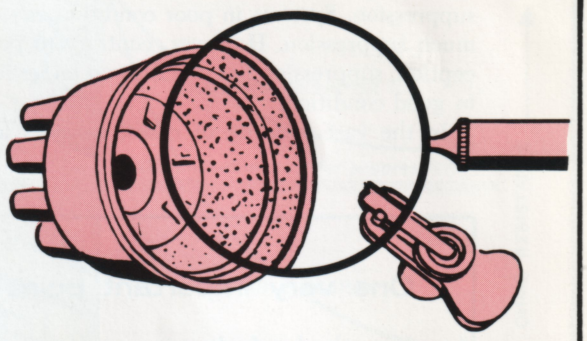


RC FILTER FOR BYPASSING THE VOLTAGE REGULATOR FIELD CONNECTION

OF "SECONDARY" IMPORTANCE

Distributor Cap and Rotor Maintenance

Rotors and distributor caps should be replaced at 25,000 miles. Never file a rotor tip—replace. After 25,000 miles, the inside of the distributor cap is impregnated with millions of metallic throw-off particles. To keep interference levels at a minimum, replace the cap. Remember rotor gaps cannot be measured.

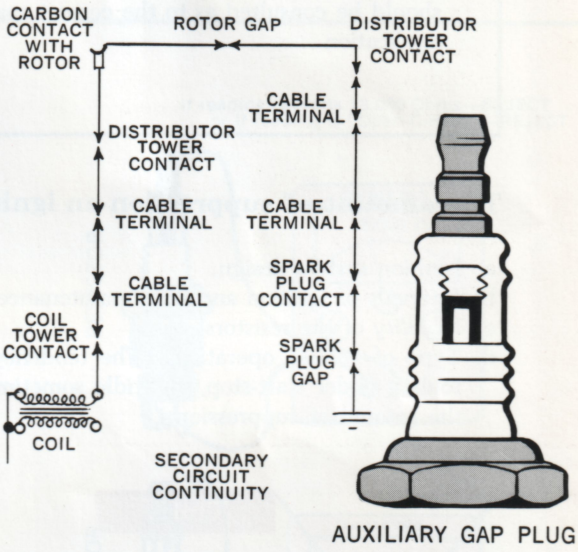


Conclusions on Continuity

Ready for a bombshell? While high tension continuity is important, it is more important in sustaining good ignition than in the reduction of radiation.

Poor high tension continuity should be corrected, for if undetected, it can gradually deteriorate ignition efficiency. But minor tolerances are not major sources of radio interference. This was proved in exhaustive tests.

Prior to the introduction of the auxiliary gap spark plugs (which relieve serious plug fouling problems), the .050″ series gap at the terminal stud of the plug was subjected to extensive radio interference monitoring . . . no additional noise appeared from the standard broadcast band through 400 mc!



Suppressor Type Cable

This type of high-tension ignition cable uses a resistor center conductor instead of wire. Several variations have been manufactured in the past, usually about 4000 ohms per foot, and were identified as "radio" or "radio resistance" etc. Present-day standards specify two types: HTLR (3000 to 7000 ohms per foot) and HTHR (6000 to 12,000 ohms per foot).

Resistance values will generally change during service . . . time, temperature, high voltage, vibration, rough handling, all take their toll. In general, it is good practice to make a resistance check whenever the ignition system is serviced. A rule-of-thumb to follow is this: replace the cables when the resistance value exceeds 18,000 ohms per foot.

ALWAYS REMEMBER

1. Never "rough-house" resistor cable. Pull on the boot—not the cable!
2. Never cut a resistor cable to attach a screw-on suppressor.
3. Never attempt to repair an end terminal—replace the cable, preferably the entire set.

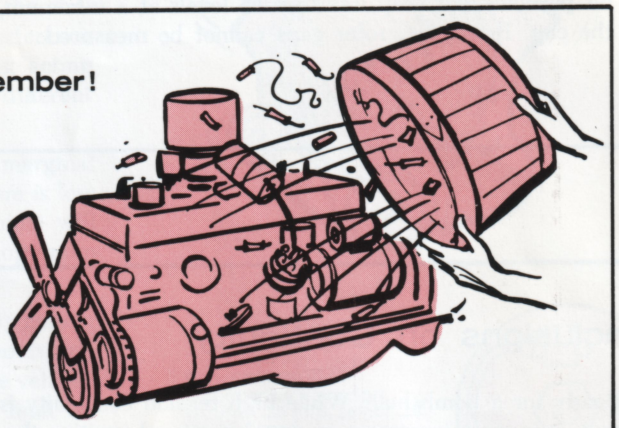
Resistance Limits

Ignition system condition is a major factor in applying suppression. Systems in poor condition cannot tolerate much suppression. However, contrary to popular conception, suppression has no effect on an ignition system in good condition.

In the vast majority of cases, resistors are not the cause of poor engine performance. Extensive investigation has revealed carburetor maladjustment or poor ignition . . . not unstable resistors . . . as the primary cause. In fact, sub-zero starting is usually faster with resistor spark plugs than with standard plugs. This was proved by military tests.

One very important point to remember!

If spark plug fouling is a problem with specific vehicles or a type of fleet operation, high series suppression may result in poor ignition performance. Consequently, two-way radio fleets should not "pile on" suppressors if spark plug fouling has been a problem. Champion service engineers should be consulted as to the correct spark plug application.



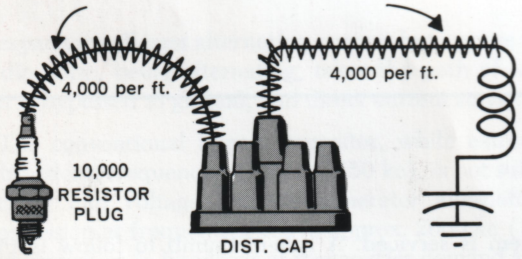
The amount of suppression an ignition system can tolerate depends upon:

a. Ignition system design.
b. Intervals of ignition and plug maintenance.
c. *Stability* of the resistors.
d. Type of vehicle operation. (The tendency toward fouling under start-stop, long idle sometimes limits the amount of suppression.)

Series resistance values are usually higher in two-way radio. While suppression-type cables are adequate over standard broadcast bands, radio equipment manufacturers generally recommend resistor plugs (10,000 ohms) in series with suppression-type cables. (Most cables are approximately 4,000 ohms per foot.)

THIS

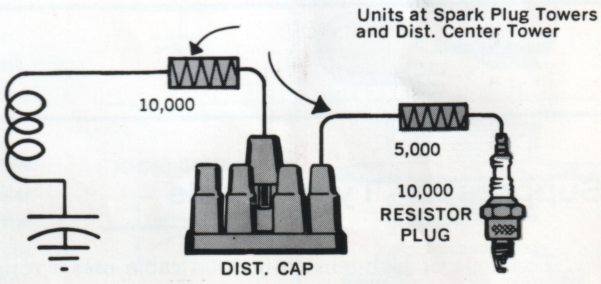
(A) RESISTANCE CABLE



Never cut a resistor cable to insert a suppressor unit.

OR THIS

(B) SUPPRESSORS



Do not use an external suppressor unit at the distributor center tower if cap contains a suppressor.

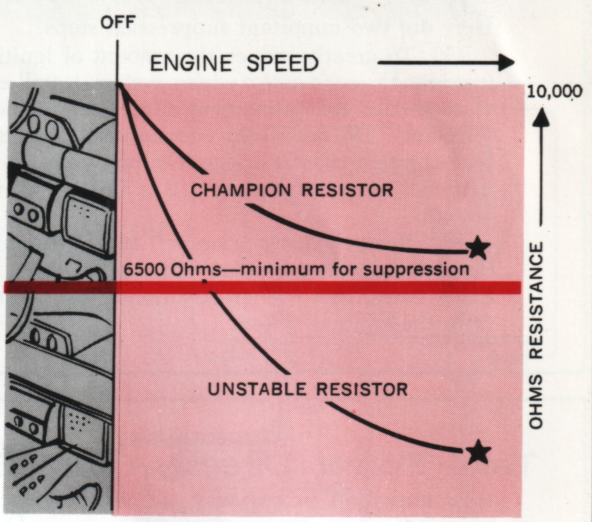
Many ignition systems incorporate a resistor in the rotor. This acts the same as an individual suppressor at the center tower.

You can usually make a choice: (A) resistor plugs with suppression cable, or (B) resistor plugs with a 10,000 ohm external type suppressor in the center of the distributor and 5,000 ohm suppressors in the castles. Many operators of heavy duty vehicles have a preference for (B). Combining these two alternatives is not recommended.

Stability Most Important

A spark plug's internal resistor must be specifically designed to tolerate sizzling heat in addition to high voltage bombardment. Its ability to keep within an ohmic range despite thermal and electrical stress is called its STABILITY. Unstable resistors can result in poor radio noise suppression, poor economy and faulty engine performance.

GOOD QUALITY			POOR QUALITY		
Volts	Temp.	Resistance	Volts	Temp.	Resistance
3	70°F	10,000 ohms	3	70°F	10,000 ohms
3	500°F	8,230 "	3	500°F	2,300 "
5,000	70°F	9,530 "	5,000	70°F	7,800 "
5,000	500°F	7,800 "	5,000	500°F	1,700 "



★Resistance—Engine Running
High Voltage and high temperature

Testing Resistor Plugs

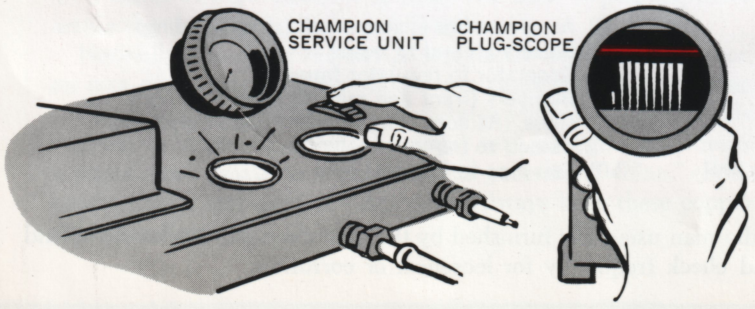
Poorly designed resistors may rise in resistance value during normal service. Even the best resistors may rise in resistance value if they are operated in service at excessive temperature and/or voltage. High resistance can result in faulty engine performance and poor fuel economy.

As noted in the above graph, garage equipment will not accurately measure spark plug resistance. Heat and high tension stress cannot be duplicated out of the engine. A low-voltage ohmmeter is useful as a "rough check" on resistor stability. If a resistor exceeds 18,000 ohms on a low-voltage ohmmeter, it should be considered suspect to failure. An open-circuit reading indicates a completely failed resistor.

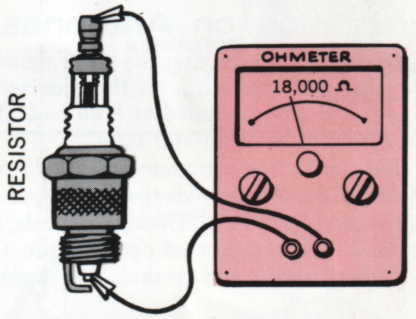
NOTE: Non-resistor plugs should *not* be checked with a low-voltage ohmmeter. Minute harmless physical tolerances within the plug may register open-circuit with a low-voltage meter. At higher voltages, these tolerances have no detrimental effect on plug performance.

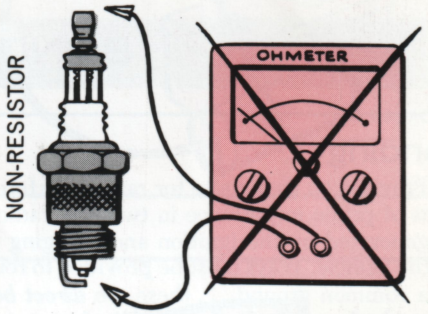
Testing resistor spark plugs in a Service Unit is accurate, providing the operator remembers that a resistor plug does not by nature give a bright, intense spark. Closer observation of the spark is required. On older Service Units, never compare a standard plug to a resistor plug. Never test resistor plugs with other high tension or alternating current devices.

The Champion Plug-Scope provides an excellent indication of resistor plug performance under actual engine conditions. Voltage levels of resistor and regular plugs are virtually the same.

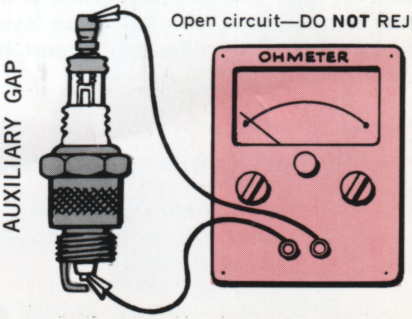


If reading exceeds 18,000 Ohms—REJECT
. . . or if reading is "Open-Circuit"—REJECT





Open circuit—DO **NOT** REJECT



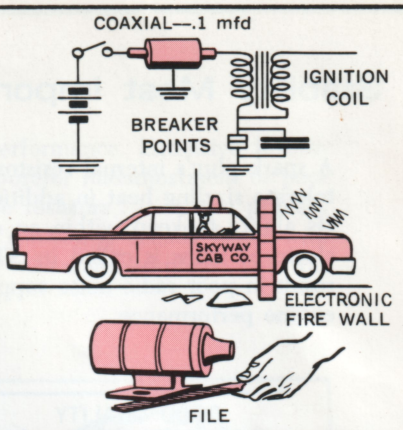
Champion auxiliary gap U-types have an inherent open circuit at 3 volts. This gap is designed to relieve serious plug fouling problems.

Build an "Electronic Fire Wall"

Here are two important suppression steps!

(1) To greatly reduce the amount of ignition interference being transferred to the car's *entire* wiring system, install a coaxial 0.1 mfd. capacitor as close to the coil primary terminal as possible (*not* the coil-dist. primary terminal). Do not use a conventional bypass capacitor but a filter-type, feed-through coaxial design. Ordinary bypass types are effective within an extremely limited frequency (3 to 5mc) range when installed in the primary circuit.

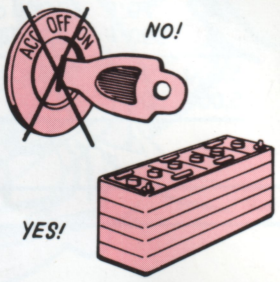
(2) Remove the ignition coil and its mounting bracket. Clean paint off the coil mounting bracket and engine block. Then reassemble tightly. In many cases, this will greatly reduce the amount of interference radiated from the ignition system.



Take Power Directly From Battery

Also important in two-way suppression is connection of your receiver-transmitter voltage directly to the battery. Do not tap into the accessory-ignition switch. Feedback and intercoupling can result, causing interference between the car's electrical system and the radio circuit.

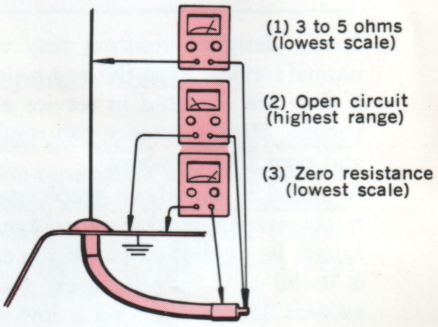
Always establish a clean radio ground at the vehicle frame. Ground battery to the frame . . . engine ground does not suffice.



Ammunition on Antennas

In addition to picking up the radio signals, the antenna should deliver these signals interference-free to the receiver. Make certain the coaxial lead-in shield is firmly grounded at *both ends*. Insulation should be inspected and all connections clean and tight.

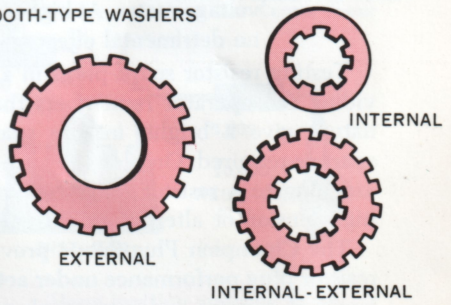
Here are three ohmmeter checks you can make on an antenna . . . (1) On lowest scale, touch prods to antenna rod and coaxial plug. Resistance should not exceed 5 ohms. (2) On highest scale, touch prods to antenna and vehicle ground. You should read open circuit. (3) On lowest scale, touch prods to outside of socket and ground. You should get zero resistance.



BOND FOR BEST RESULTS

Bonding

Provides an easy route for radio-interference currents to reach ground. This is of prime importance in two-way radio to keep radio interference signals generated by the ignition and charging systems from traveling throughout the vehicle. Ways must be provided to route this troublesome interference to a common ground . . . these are *direct bonding* and *strap bonding*. In both methods, a physically clean surface is inadequate: tooth-type lockwashers must be used to cut into the surface layers of the metal. Sheet metal screws are inadequate. Bonding straps must be shock mounted and as short as possible.



Typical bonding points are:

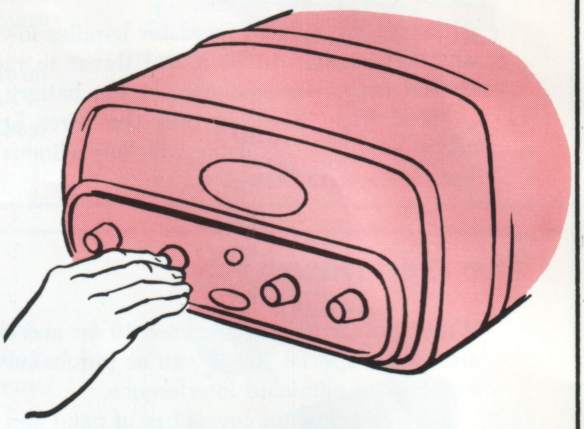
1) Corners of engine to frame
2) Exhaust pipe to frame and engine
3) Hood (both sides)
4) Trunk lid (both sides)
5) Coil and distributor to engine and fire wall
6) Air cleaner to engine block (strap bonding)
7) Battery ground to frame
8) Generator to regulator frame
9) Bumpers (front and rear) to frames on both sides. (Be sure both bumper support arms are welded to frame on both sides)
10) Tail pipe to frame at rear

While bonding is usually accomplished by a radio man using kits furnished by the manufacturer, mechanics should acquaint themselves with these connections and check frequently for looseness or corrosion.

MOST IMPORTANT! TAKING THE "SQUELCH" FROM FM

FM is now used almost exclusively in mobile communication. While ignition interference is comparatively simple to track down in AM receivers, FM is an entirely different and difficult matter. Ignition interference can override FM reception at long distances, yet go unnoticed at modest range from the base transmitter.

A tune-up man usually cannot easily seek out ignition noise in the shop because he's too close to the base transmitter. But, most important is the fact that most commercial FM receivers remain mute except when receiving a communication from their own base station.



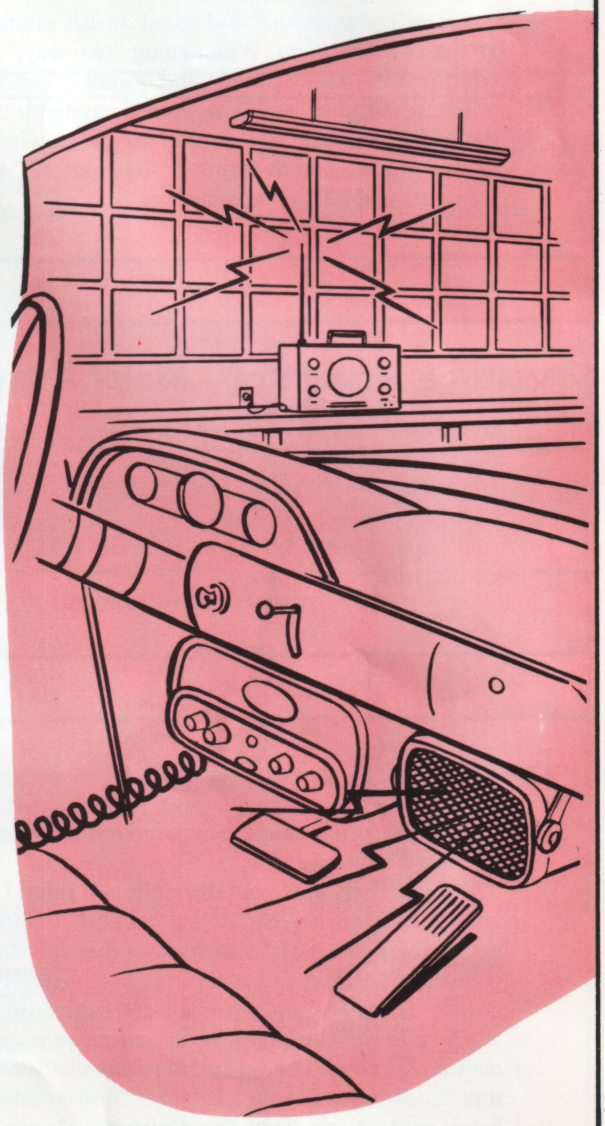
This is called *"squelch control."* To complicate things even more, some squelch circuits are keyed to an initial supersonic tone (or two supersonic tones if two fleets are using the same frequency in an area). Only the base station transmission can actuate these receivers. To track down ignition interference or find how effective suppression is, the receiver must be "open." On some receivers, this can be accomplished by lifting the microphone; however, on some installations, only a qualified radio technician can open the circuit.

With the receiver open, a mechanic can attempt to seek out interference by turning the squelch control until background squelch noise *just* disappears and then adjusting the volume control to a tolerable level. This method is effective where very strong interference is present, but it does not locate the weaker interference which can override the signal at maximum range from the transmitter. This is an unsatisfactory method as it does not simulate fringe reception.

A very effective way to locate interference sources utilized by some radio technicians is a detector-amplifier probe, which "sample" for noise ahead of the squelch circuitry. (See page 14.)

Another excellent technique is to have a qualified radio man "burst" an AM *audible* signal thru the FM receiver. A RF (radio frequency) generator is set up near the vehicle emitting a strong RF signal. This sustained frequency "bursts thru" the FM squelch setting up an audible signal thru the receiver. With the receiver *at full volume*, the signal generator is *reduced in power* to emit a weak signal.

This procedure simulates weak base station reception—exactly the same as the vehicle would encounter at a long distance from its base station transmitter. Trouble-shooting and suppression can now be accomplished accurately and effectively, using the FM receiver and running the vehicle's engine.



SOUND AND THE JURY

Here's a sound chart to guide you thru the sea of noises you may hear in your receiver. It's best to check these out at maximum range from your base transmitter.

If all suppression is done in the garage, remember a qualified radio man must not only penetrate the squelch, but send an RF (Radio Frequency) signal thru your FM receiver. Or, you can chase the interference with a "Noise Chaser" amplifier probe. Remember to keep the signal as weak as possible . . . but strong enough to keep the squelch open. This simulates maximum range reception . . . only then will the real gremlins prowl the premises. Attack them one by one.

Ignition System

"Popping" . . . increases in tempo with higher engine speed, stops instantly when ignition key is shut off at fast idle (hi-voltage secondary circuit).

Charging System

"Hi pitched musical whine" . . . does not stop instantly when ignition is shut off at fast idle; depressing clutch sometimes changes pitch. (Generator)

"Ragged, rasping sound" . . . does not stop instantly after ignition is shut off at fast idle, usually heard in conjunction with generator whine. Rasping is not at a uniform rate but random. (Voltage Regulator)

Instrumentation

"Hissing and crackling" . . . usually heard when various gauges are jarred with ignition on. Gauges employing rheostats are most likely to give trouble.

"Low pitched clicking" . . . generally caused by the oil sender. Clicking rate will vary at different oil pressures. (Don't forget some instrument clusters have a small voltage regulator which *must* be bypassed.)

Wheels and Tires

(Car must be in motion)

Irregular "popping" or "rushing" sound . . . this occurs only in dry weather at higher speeds. When brakes are lightly applied, sound disappears. (No static collectors in wheel hubs, or cotter key in wheel spindle is touching static collector; no anti-static powder in tubes. In extreme cases, ground the brake shoes.)

SIZING UP OR "X" MARKS THE SPOT

No matter what the application—police cars, fire engines, ambulances, delivery trucks, executive cars, off-highway equipment, yachts or sports fishing boats—Champion has a resistor plug to mate perfectly to the engine. Merely consult our regular size chart for the standard recommendation, then specify the prefix "X" ahead of the type number.

DEPENDABLE CHAMPION SPARK PLUGS

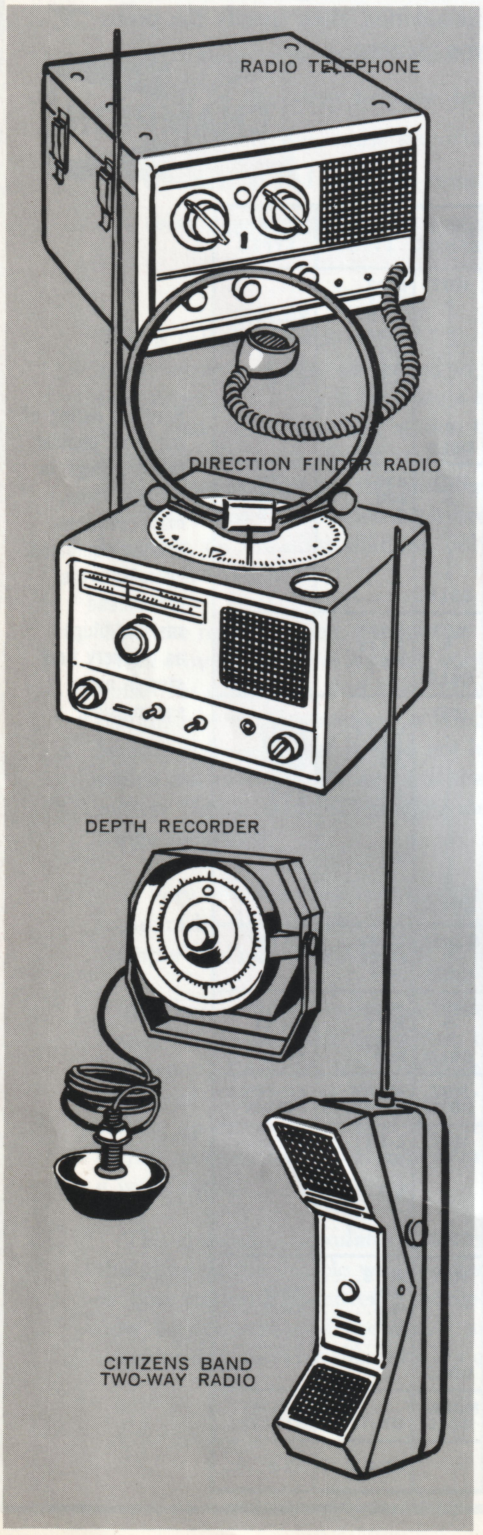
THREAD SIZE	HEAT RANGE	REGULAR TYPES	RESISTOR TYPES
18mm With Gasket	HOT ↑ ↓ COLD	D-23	. . . . .
		D-21	. . . . .
		D-16	XD-16 . . .
		D-14	XD-14 . . .
		D-10	. . . . .
		D-9	XD-9 . . . .
		D-6	XD-6 . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
18mm Tapered Seat	HOT ↑ ↓ COLD	870	X-870 . . .
		860	X-860 . . .
		F-10	XF-10 . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
18mm Tapered Seat Proj. Core Nose	HOT ↑ ↓ COLD	F-14Y . . .	XF-14Y . .
		F-11Y . . .	XF-11Y . .
		F-9Y	XF-9Y . . .
		. . . . .	. . . . .
14mm ⅜" Reach	HOT ↑ ↓ COLD	. . . . .	. . . . .
		UJ-12 . . .	XJ-12 . . .
		J-11	XJ-11 . . .
		J-8	XJ-8 . . . .
		. . . . .	. . . . .
		J-7	XJ-7 . . . .
		J-6	XJ-6 . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		J-4	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
14mm ⅜" Reach Proj. Core Nose	NORM. ↕ COLD	J-18Y . . .	XJ-18Y . .
		J-12Y . . .	XJ-12Y . .
		J-9Y	. . . . .
14mm 5/16" Reach	HOT ↑ ↓ COLD	H-12	XH-12 . .
		H-11	XH-11 . .
		H-10	XH-10 . .
		H-8	XH-8 . . .
14mm, 5/16" Reach Proj. Core Nose	HOT COLD	H-18Y . . .	XH-18Y .
		H-14Y . . .	XH-14Y .
14mm ½" Reach	HOT ↑ ↓ COLD	L-10	. . . . .
		L-7	XL-7 . . . .
		. . . . .	. . . . .
		L-5	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
14mm ¾" Reach	HOT ↑ ↓ COLD	N-18	. . . . .
		N-8	XN-8 . . . .
		N-5	XN-5 . . . .
		N-3	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
		. . . . .	. . . . .
14mm, ¾" Reach Proj. Core Nose	NORM. COLD	. . . . .	XN-16Y .
		UN-12Y .	XN-12Y .
10mm		UY-6	XY-6 . . . .

Here's a listing of our most popular resistor plugs. In two-way radio, most communications equipment manufacturers recommend resistor plugs as the **very first step** in noise suppression.

Outboard Manufacturers
NOW OFFER
Suppression Kits

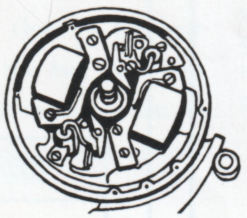
Marine radio, usually being AM and confined to 2 to 3 megacycles, is very susceptible to ignition interference. This interference can spoil voice communication . . . and cause radio direction finders, "fish finders," and fathometers to become inaccurate.

Outboard manufacturers, aware that the 2-cycle armadas are taking aboard radio and electronic navigational equipment at an unprecedented rate, are now releasing suppression kits. Details on kits currently available are listed below. Others will be available soon. These should greatly reduce



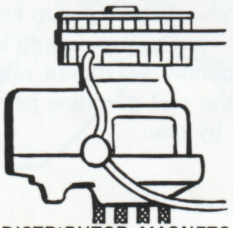
OUTBOARD MARINE CORPORATION — *Johnson, Evinrude, Gale*

35-40 HP



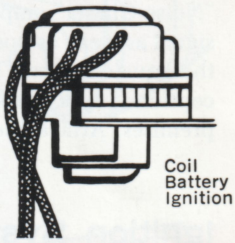
FLYWHEEL MAGNETO

50-60-75 HP

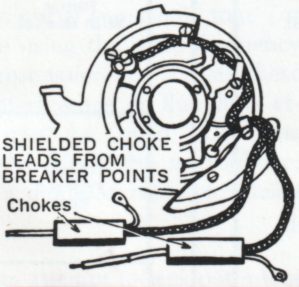


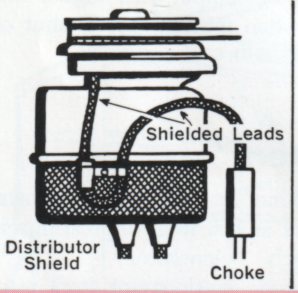
DISTRIBUTOR MAGNETO

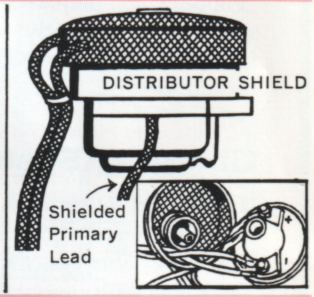
75 HP with Alternator



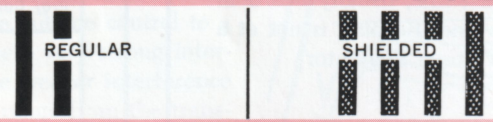
MODIFICATIONS TO PRIMARY AND SECONDARY







SPARK PLUG CABLES

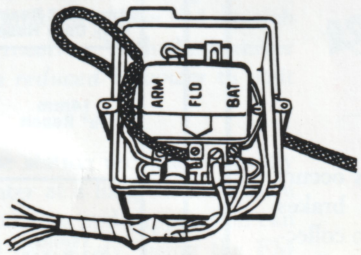


SPARK PLUG TYPES

CHAMPION J-4-J or XJ-4J*

CHAMPION J-4-J or XJ-4J*

GENERATOR CHARGING SYSTEM

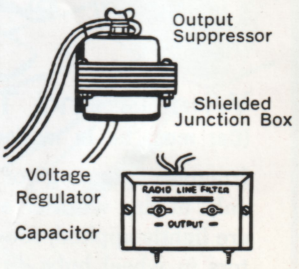


SHIELDED LEADS

SUPPRESSOR

CAPACITORS

ALTERNATOR



The plating on Champion outboard plugs provides an excellent ground. The shielding "can" completely covers the plug and has three internal grounding "nibs" which contact the shell of the spark plug.

*Champion XJ-4J's are included in the suppression kit for flywheel magnetos. However, with a shielded system, the outboard operator has a choice of our regular or resistor plugs. The J-4J's will generally give better performance in prolonged trolling operations. Unless you have a thorough knowledge of outboard ignition and charging systems, Outboard Marine recommends these kits be installed by their dealers.

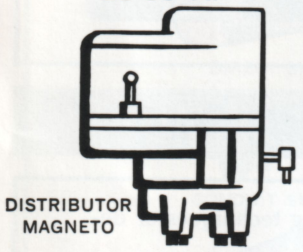
SION

radio noise, inaccuracies with DFR equipment and random spikes on the periphery of depth recorders.

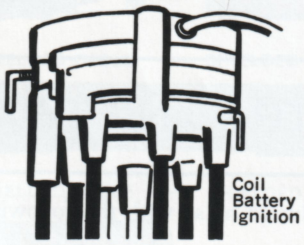
Here is a brief outline of some of their suppression measures . . . designed to "quiet" the various types of outboard ignition systems. For complete details on components and costs, consult with the outboard dealer. Those planning to have kits installed at a later date may find the tips listed at the right of the page useful.

KIEKHAEFER CORPORATION — *Mercury*

25-50 HP



60-70-80 HP



NOTE: Mercury's complete suppression harness consists of a new distributor cap, distributor-coil cables, and spark plug suppression cables. The kit is complete. Make no attempt at "do-it-yourself" installations with automotive type suppression cable.

SPARK PLUG CABLES

SPARK PLUG TYPES

NOTE: * Resistor (X prefix letter) spark plugs in series with suppressor type cables are not recommended on Mercury 4-cylinder magnetos. Resistor spark plugs may be used with Mercury's coil-battery 6-cylinder ignition if owner desires. Use only J-4J or XJ-4J heat range in 80 h.p. model.

CHAMPION OUTBOARD SPARK PLUGS

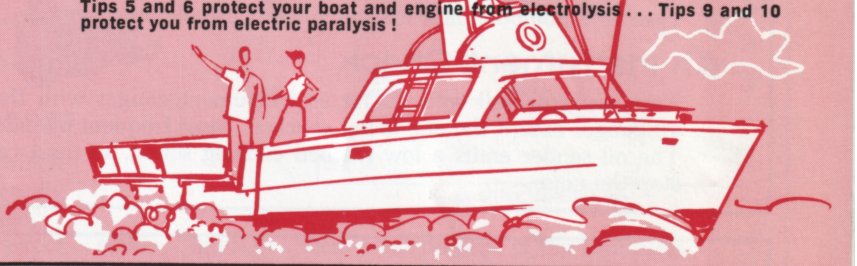
		HOT / COLD	RESISTOR	REGULAR
14mm 3/8" reach		HOT		J-14J
			XJ-12J	J-12J
				J-11J
			XJ-8J	J-8J
				J-7J
			XJ-6J	J-6J
			XJ-4J	J-4J
		COLD		J-2J
14mm 7/16" reach		HOT		H-12J
				H-11J
			XH-10J	H-10J
		COLD	XH-8J	H-8J

ALL OUTBOARD RESISTOR PLUGS ARE SPECIAL ORDER

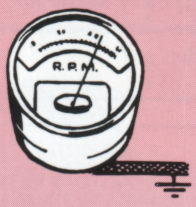
10 TIPS FOR GOOD MARINE RECEPTION

1. **Use a marine type approved antenna — not automotive type — one that has proper electrical characteristics for the frequency on which it is to operate.**
2. **Install antenna opposite side of remote control engine panel and as far forward in bow as possible.**
3. **Use a shielded lead-in wire. Ground the metal braid to radio cabinet.**
4. **Fiberglass and wooden boats require at least a 12 sq. ft. under-hull ground plate, or a commercially available radio ground plate.**
5. **Plate should have only one (#10) grounding wire connected from plate to the negative battery post.**
6. **All electronic and electrical equipment should terminate their ground at the negative side of the battery, not directly to the plate.**
7. **Interference from small electric motors (windshield wipers, bait wells, bilge pumps, etc.) can be eliminated by installing a generator capacitor from the hot input lead to ground. The capacitor should be installed as near the offending device as possible.**
8. **Metal boats do not require a ground plate, provided the electrical system is grounded to the hull. If possible, route all wiring under the metal rails of the boat.**
9. **Check all boat wiring — be certain no wires run thru a leaky bilge.**
10. **Do not handle radio equipment, especially transmitting equipment, when standing in bilge water or wearing water soaked shoes. It is best to disconnect the hot lead or remove the line fuse when working on electrical equipment.**

Tips 5 and 6 protect your boat and engine from electrolysis . . . Tips 9 and 10 protect you from electric paralysis !

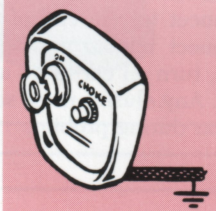


Two Bad Offenders



If you plan to install suppression kits at a later date, these "home made measures" may help temporarily.

Noticeable reduction in radio noise level can often be attained by shielding the entire length of the tachometer wire from the control panel to engine. As the tach picks up its impulses from the ignition primary, these undesired signals can radiate like an antenna along the entire wiring. Remember to ground the shielded part of the wire to the engine. Some ignition tachometers may require adjustment or may not work at all if shielding is added, because the shielding may change the characteristics of the tachometer impulses.



Other troublesome origins of interference are magneto grounding wires or battery ignition wires running from the engine to the control panel ignition switch. They should also be shielded and the metal braid grounded. No attempt should be made to alter remote control cables. However, large diameter woven metal braid can be slipped over the electrical cable assembly and this should be grounded at the remote control and engine.

On outboards using battery ignition, a "feed thru" coaxial 0.1 mfd. capacitor installed as close to the first coil as possible (between switch-coil lead, **not** coil-dist. lead) will keep unwanted radio noise from associated boat wiring.

SPECIAL NOTE:

Manufacturers' kits will not affect engine performance . . . providing ignition is in top shape. Outboards that tend to foul plugs may have greater difficulty when suppression is installed.

Before suppressing, correct the causes of fouling. Look for excessive combustion chamber deposits, poor breaker point synchronization, clogged passages in the manifold bleed-off system, tracks in distributor cap, improper carburetion and poor coordination of spark advance controls in conjunction with carburetor butterfly movement.

Some outboards operated at low speed (for example, slow troll) may misfire from a carbon build-up between the plug electrodes even though the insulator remains fairly clean. Outboards not usually prone to this type of fouling may become susceptible to "gap bridging" once suppression is installed. It is good practice to inspect plugs more frequently. There is evidence outboard coil-battery ignition is less troublesome in this respect.

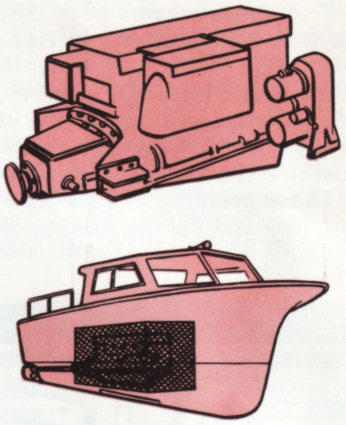
Use of the proper gasoline and the recommended type and amount of oil is **most important** – with or without suppression!

If your outboard is not listed on these pages, consult with your manufacturer before installing suppression.

HOW ABOUT MARINE INBOARD ENGINES?

Inboard engines do not have the intrinsic "built-in" metal shielding of auto hoods and bodies, nor do they have an adequate ground. While automotive engine two-way suppression techniques still apply, an efficient ground must be established. Most boat owners use a copper grounding plate fastened to the hull. An effective way to suppress engine noise is to screen the engine compartment. (Use copper or bronze screening—connect to radio ground plate.) Commercially available, easily attached engine shields are also effective.

Electrical gadgets on board should be quieted with bypass capacitors: ground the cabinets and frames of these devices. Some other rare and seldom checked sources of static are metal riggings rubbing together, turnbuckles and shackles "sounding off" at certain propeller frequencies and dissimilar underwater metal fastenings generating voltages around the propeller shaft.



WHEN ALL ELSE FAILS—SOME TRACING TECHNIQUES

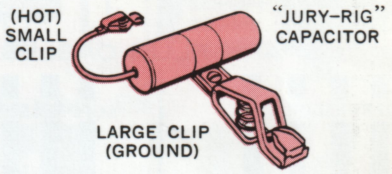
If all usual suppression methods fail, you may be able to ferret elusive noise with the following techniques or devices in automotive and marine inboard installations.

An Instrument Check

Turn on radio full volume. Jar all instrument gauges with the ignition switch *on*. Disconnect the "hot" leads of all gauges except the one being checked. Most frequent offender is the temperature gauge ("hissing or crackling"). The oil sender emits a low pitched clicking sound. In most cases, a .25-.50 mfd. bypass capacitor to ground will stop the noise.

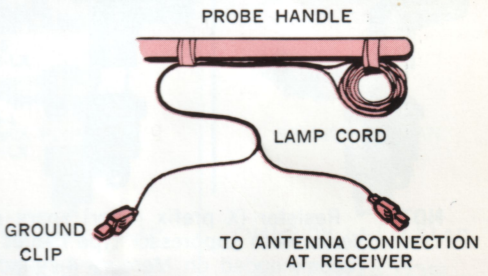
"Pigtail Checks"

A grounded capacitor touched to all electrical connections and all unsuppressed small motors (blowers, air conditioners, etc.) at the hot input wires or brush holders will often locate other offenders. Install a bypass capacitor if your "jury-rig" capacitor isolates the offender.



"Sniffer" Coil

Wrap 50 turns of insulated wire (ordinary bell wire) into a coil 2 inches in diameter . . . mount on broom handle . . . connect to one end of coil with ordinary lamp cord to antenna lead (disconnect regular antenna), other end to ground terminal of radio. Start engine, turn on car radio and probe around engine and car wiring with sniffer coil. Any elusive noise source will be amplified. Remember to bounce or shake car during probing.

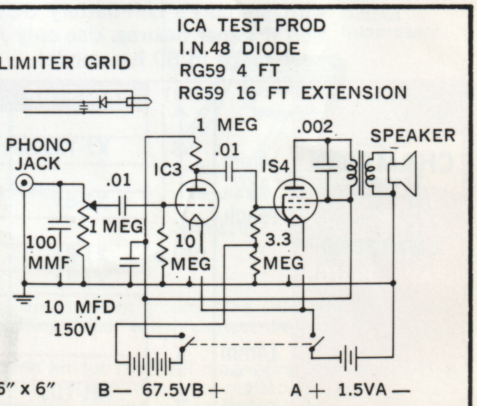


FM "Noise Chaser"

Although FM circuits reduce *audible noise*, ignition interference can still greatly lower the *sensitivity* of the receiver and limit the *range* of reception. Consequently, we must seek out the interference by producing a sound even when the *FM is quiet*.

The schematic of a FM Noise Chaser is shown. It is a battery-powered "do-it-yourself" kit with a 20-foot extension cable and a ground clip.

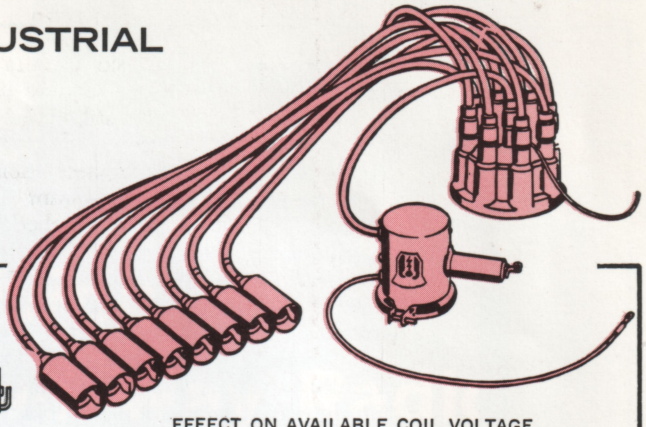
SOURCE: "Death, Taxes, Ignition Noise" G. A. Svitek.



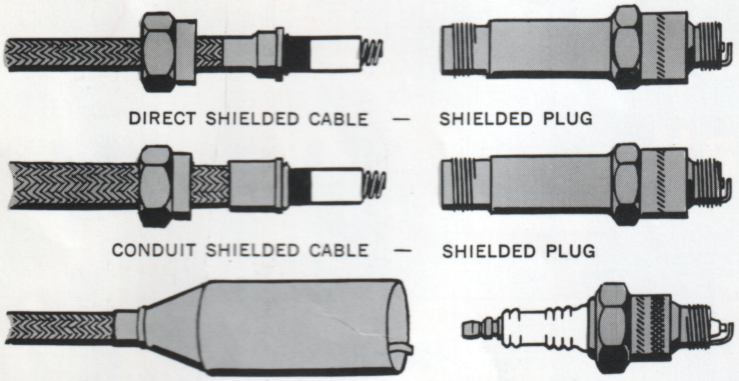
UNSHIELDED FACTS ABOUT SHIELDED IGNITION

AUTOMOTIVE—MARINE INBOARD—INDUSTRIAL

Shielded ignition offers the most effective combination of radio suppression and moisture proofing. However, shielding may have certain effects on ignition performance. Here's the story . . .



Types of Shielding



DIRECT SHIELDED CABLE — SHIELDED PLUG

CONDUIT SHIELDED CABLE — SHIELDED PLUG

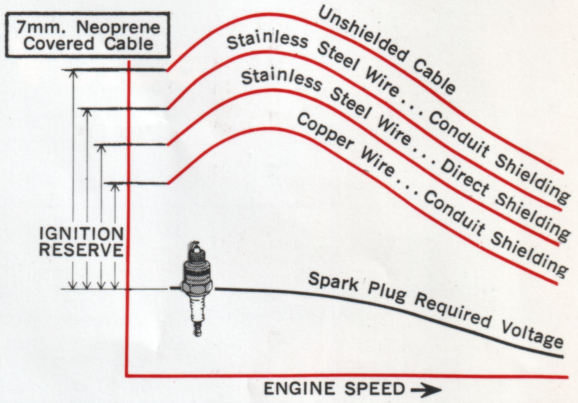
DIRECT SHIELDED CABLE—PLUG SHIELD—UNSHIELDED PLUG

When an ignition system is shielded, the voltage which the coil is able to deliver to the spark plugs is materially reduced . . . spark plug cables are the most critical.

Shielded spark plug cables which have the least effect on coil voltage are shown in the graph. For maximum coil voltage, keep your hi-tension leads as short as possible . . . ignition system must be kept in top condition.

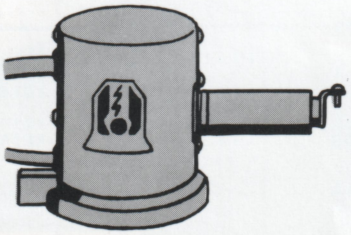
If shielding causes marginal engine performance, it may be necessary to install a higher output coil.

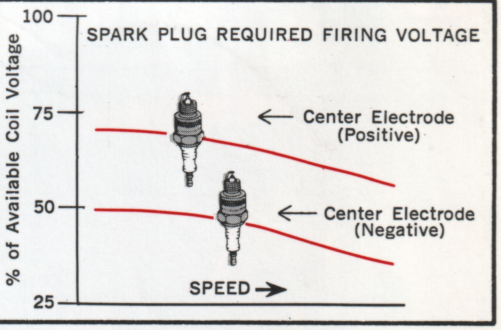
EFFECT ON AVAILABLE COIL VOLTAGE


7mm. Neoprene Covered Cable
Unshielded Cable
Stainless Steel Wire . . . Conduit Shielding
Stainless Steel Wire . . . Direct Shielding
Copper Wire . . . Conduit Shielding
IGNITION RESERVE
Spark Plug Required Voltage
ENGINE SPEED

Correct Coil Polarity

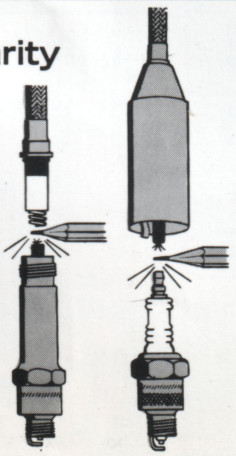
Spark plugs require less voltage with correct coil polarity. (See chart.) Inadvertently reversing primary leads at coil when making shielded installations can affect spark plug performance.



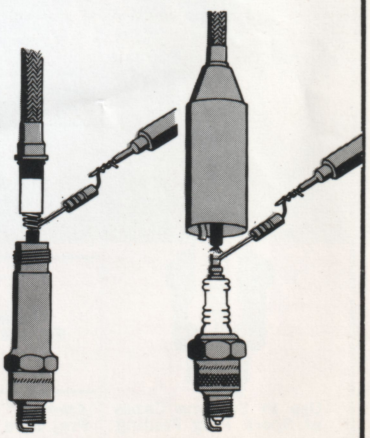


Ways To Check Polarity

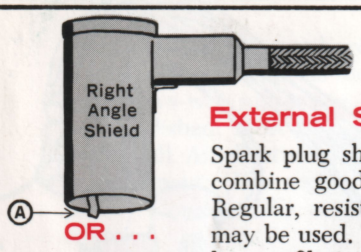
Using a timing light adaptor or length of hi-tension cable, as shown in the illustrations, insert point of wooden pencil into jump spark. Spark should flare and turn orange on *plug side* of pencil. If flare and orange tint are toward connector, reverse coil leads.



An *inexpensive* voltmeter or milliameter can also be used. Connect positive meter terminal to engine ground. Fasten a resistor (approximately one hundred thousand ohms) to the negative test prod. Start the engine and touch the end of the resistor *momentarily* to the spark plug connector. If the needle kicks upscale, the polarity is correct, if downscale incorrect. The spark plug will misfire momentarily when contact is made.



APPLICATIONS OF UNSHIELDED PLUGS AND SHIELDED PLUGS



OR . . .

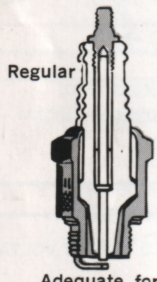
External Spark Plug Shields

Spark plug shields with direct shielded cables combine good performance with lower costs. Regular, resistor or auxiliary gap spark plugs may be used. The right angle plug shield offers low profile installation advantages.

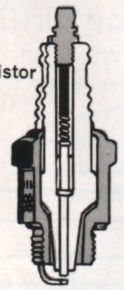
Most Important (A) The spark plug shield contains an inside ground spring that must contact the shell of the spark plug. This provides a path to engine ground for unwanted radio interference. *Champion plated plugs are recommended and preferred by the shielding manufacturers as providing an excellent ground and minimum radio interference.*

Shielded Plugs with Harness

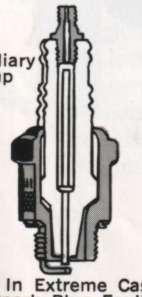
Before converting to a fully shielded conversion, make certain adequate clearance exists to accommodate overall height of shielded plug and connector. With conduit type shielding, avoid use of cambric covered or plastic hi-tension wiring. The addition of shielding to the hi-tension system may make it necessary to install a higher output coil. Plugs should be regapped and serviced more frequently to keep voltage requirements at a minimum.



Adequate for Most Applications

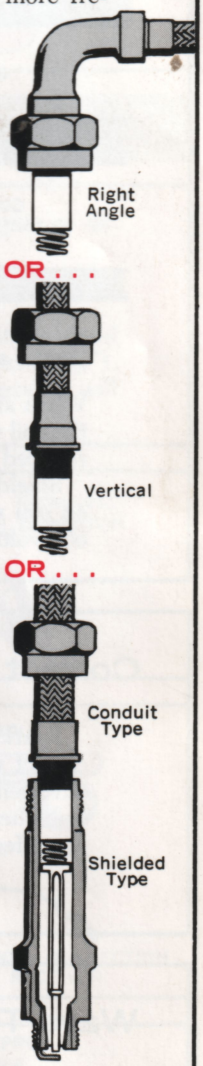


Required Only In Extreme Cases of Interference



Use In Extreme Cases of Spark Plug Fouling

THREAD SIZE	HEAT RANGE	REGULAR TYPES	AUXILIARY GAP TYPES	RESISTOR TYPES	SHIELDED RESISTOR	SHIELDED TYPES
18mm With Gasket	HOT ↑ ↓ COLD	D-23, D-21, D-16, D-14, D-10, D-9, D-6	UD-16, UK-10	XD-16, XD-14, XD-9, XD-6	XED-16, XED-14	ED-16, ED-14, ED-9
18mm Tapered Seat	HOT ↑ ↓ COLD	870, 860, F-10		X-870, X-860, XF-10	XEF-15	EF-15, EF-10
18mm Tapered Seat Proj. Core Nose	HOT ↕ COLD	F-14Y, F-11Y, F-9Y		XF-14Y, XF-11Y, XF-9Y		EF-14Y
14mm 3/8" Reach	HOT ↑ ↓ COLD	J-11, J-8, J-7, J-6, J-4	UJ-12, UJ-8, UJ-6	XJ-12, XJ-11, XJ-8, XJ-7, XJ-6	XEJ-11, XEJ-8, XEJ-7, XEJ-6	EJ-11, EJ-8, EHO-8, EJ-6
14mm 3/8" Reach Proj. Core Nose	NORM. ↕ COLD	J-18Y, J-12Y, J-10Y		XJ-18Y, XJ-12Y, XJ-10Y		
14mm 7/16" Reach	HOT ↕ COLD	H-12, H-11, H-10, H-8		XH-12, XH-11, XH-10, XH-8	XEH-10, XEH-8	EH-11, EH-10
14mm, 7/16" Reach Proj. Core Nose	HOT COLD	H-18Y, H-14Y		XH-18Y, XH-14Y		
14mm 1/2" Reach	HOT ↑ ↓ COLD	L-10, L-7, L-85, L-5	UL-15Y	XL-7		
14mm 3/4" Reach	HOT ↑ ↓ COLD	N-18, N-8, N-6, N-5, N-4, N-3		XN-8, XN-5		
14mm, 3/4" Reach Proj. Core Nose	NORM. COLD	N-14Y	UN-12Y	XN-14Y, XN-12Y		



INSTALLATION-SERVICE TIPS

- When servicing shielded plugs, do not contaminate the sleeves with fingers.
- Sleeves and interior plug barrels can be cleaned with alcohol, white gas, or Stoddard solvent. Do not use carbon tetrachloride.
- Top connectors should be installed finger-tight, then tightened an additional ¼ turn.